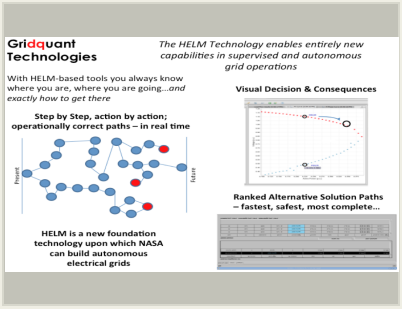
Holomorphic Embedded Load Flow for Autonomous Spacecraft Power Systems, Phase I

Completed Technology Project (2014 - 2014)

Project Introduction

The Holomorphic Embedding Load Flow Method (HELM) is a breakthrough that brings significant advances to the field of power systems. It provides a non-iterative procedure to compute, with mathematically proven guarantees even near voltage collapse, the correct operative power flow solution, to the desired accuracy. Unlike iterative methods, which are inherently prone to non-deterministic convergence failures, HELM can be used as the fundamental block for building reliable real-time network applications. The most advanced applications, which rely on optimal search techniques in the state-space of the power system and perform thousands of exploratory power flows, would be unfeasible with any of the iterative methods. This proposal addresses one of the needs of Topic S3.03, namely the need for intelligent, fault-tolerant PMAD technologies to efficiently manage system power for deep space missions. It does so at a foundational level, as it lays down the algorithmic technology that will enable a new class of real-time intelligent algorithms based on reliable, model-based computation. An example of this in terrestrial grids, which has been proven in actual deployments at some large utilities, is a Restoration plan builder, able to compute detailed restoration plans in real time, equaling or surpassing the abilities of human operators. The approach for Phase I consists in applying the new HELM power flow technology to the relevant models for the micro-grids present on current and projected spacecraft power systems, validating and benchmarking the simulation results against other current power flow technologies. This will demonstrate how this technology is better than the state of the art. By highlighting the mathematical properties of the method (unequivocal results, 100% reliability) on the models specific to autonomous DC spacecraft, we will establish the validity and also the status of HELM as the building block of future intelligent applications.



Holomorphic Embedded Load Flow for autonomous spacecraft power systems Project Image

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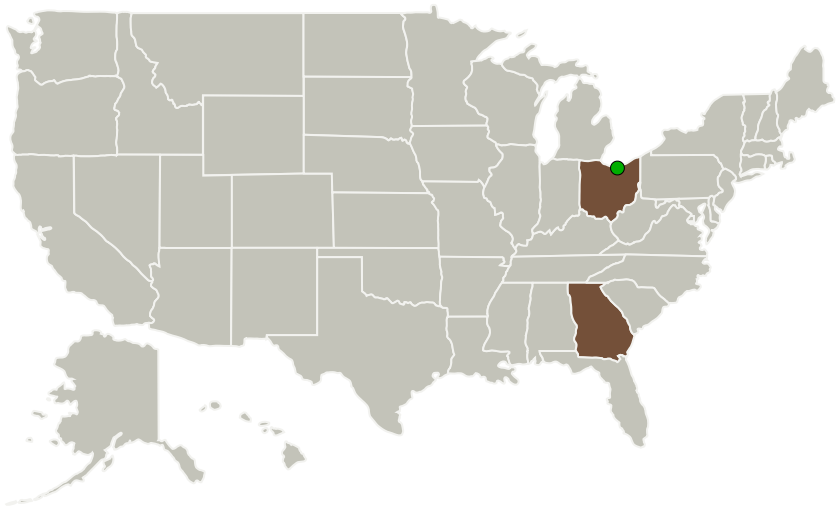
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Gridquant Technologies, LCC	Lead Organization	Industry	Duluth, Georgia
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations	
Georgia	Ohio

Project Transitions

June 2014: Project Start

December 2014: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/140596)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Gridquant Technologies, LCC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Robert B Stuart

Co-Investigator:

Robert W Stuart

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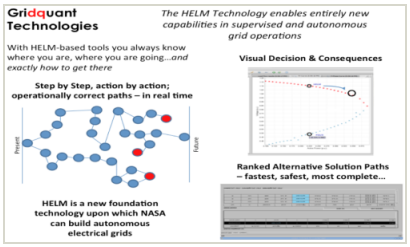
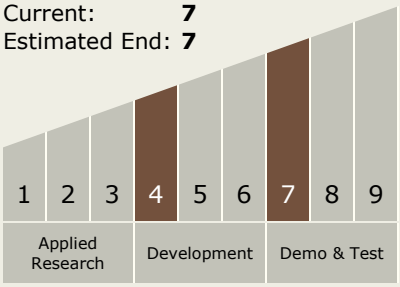
Images



Project Image
Holomorphic Embedded Load Flow for autonomous spacecraft power systems Project Image *(https://techport.nasa.gov/image/132042)*

Technology Maturity (TRL)

Start: **4**
Current: **7**
Estimated End: **7**



Technology Areas

Primary:

- TX03 Aerospace Power and Energy Storage
  - TX03.3 Power Management and Distribution
    - TX03.3.1 Management and Control

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System